APPLIED GEOGRAPHICS, INC.
Empowering People with Spatial Solutions

Colorado Geospatial Enterprise Architecture

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TABLE OF CONTENTS

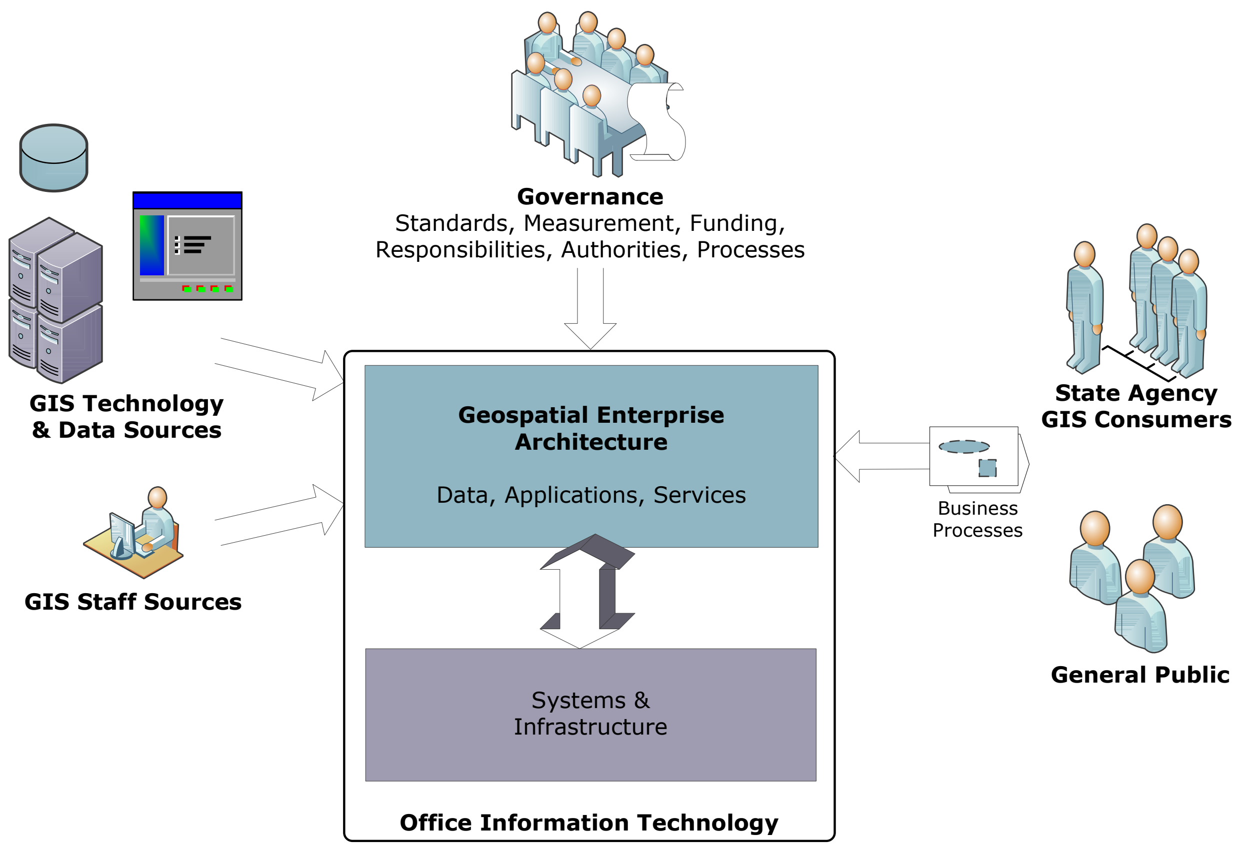
COLORADO GEOSPATIAL ENTERPRISE ARCHITECTURE (GEA)

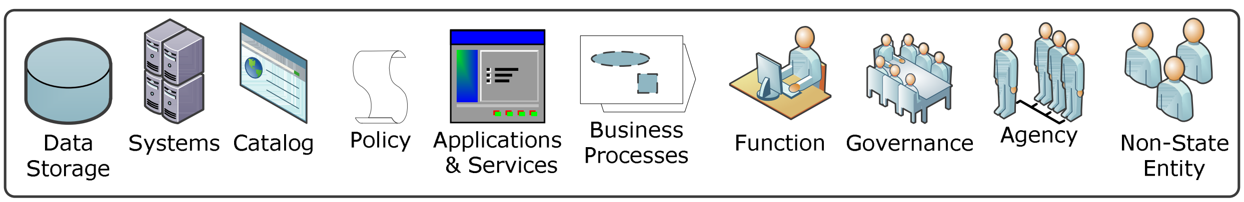
INTRODUCTION

The Colorado Geospatial Enterprise Architecture (GEA) is a unifying vision for consolidating geospatial technology resources for the State of Colorado. As part of the Colorado Consolidation Plan (C2P) for Information Technology, the GEA process involves consolidation of all GIS related personnel and technical capability under the Office of Information Technology (OIT). All personnel considerations for GIS consolidation are beyond the scope of this document. Any reference in this document to a particular work activity or job function does not address who is performing the work or to which organization they belong; rather this analysis is limited to a description of the governance, coordination, and support functional activities supporting the GEA infrastructure. This document focuses on describing a **conceptual solution** rather than providing a detailed implementation plan. It is a high-level description of the technical components, the administrative functions required to support them, and how they are governed and coordinated. It is informed from a number of inputs including interviews and workshops with GIS stakeholders, previous related work, the GIS Working Group, and this project's applications and services inventory.

The essential aspects of the GEA are **expected to evolve over time** as the enterprise needs change, implementation proceeds, and technological possibilities change. Ongoing refinement is to be expected; particularly as implementation is undertaken.

ARCHITECTURAL FRAMEWORK





Note: These symbolic icons are used through this document.

The current state of geospatial activity in Colorado state government primarily resides within state agency Lines of Business (LOB). The agency based geospatial infrastructure including systems, applications and server software, department and statewide geospatial data, and the supporting administrative functions provide the foundation for a coordinated geospatial enterprise. Any consolidation effort has potential benefits and associated risks. **Consolidation is a process of integration of work activity and resources**; this document does not imply any movement of equipment or personnel.

The current geospatial environment presents several **considerations** relevant to consolidation:

- The agency Line of Businesses define the requirements and needs for geospatial technology and are responsible for the development of the capability to satisfy those needs.

- Essentially different services have been created by the Agency Line of Businesses to support local requirements and are independent of geospatial activity in other departments.
- Geospatial capability is not evenly distributed across agencies; some agencies have more mature geospatial programs and others have little or no access to geospatial resources.
- Authority to make enterprise level decisions and provide geospatial coordination now exists with the passage of SB-155; however enterprise wide coordination activities are still not fully developed.
- The GIS Working Group found little redundant data development and acquisition during their data inventory work. The management of derivative data sets is a larger issue. The creation, storage, and revision of multiple derivative data sets consume resources inefficiently and can lead to a disconnection with the authoritative data source. For example, when hydro or road data is extended or modified to satisfy one LOB business need, the process for incorporating updates to the source data becomes much more complicated or is skipped altogether.
- Multiple application and service development capabilities exist across agencies enabling the possibility of redundant development, lack of coordination, and less than optimal code reuse across the enterprise.

A fully implemented Geospatial Enterprise Architecture will address a number of these issues and will provide a structure that delivers a number of **benefits**:

- **Coordination of geospatial efforts throughout state government:** Coordination will enable standardization of work products and provide a consistent quality in levels of service and spatial data.
- **Economies of scale resulting in reduction in costs**: For instance, a single organization can develop consistent and efficient administrative functions designed to meet the needs of the larger organization such as map server administration and software license management. Ultimately, the number of map servers and software licenses could be reduced.
- **Agencies with few resources will gain access to geospatial data and capabilities**: Greater access will facilitate the development of more advanced line of business processes. For instance, enterprise web services such as address validation could be integrated with existing LOB transaction systems to increase the accuracy of the tabular data being collected.
- **Increased interaction and knowledge transfer between GIS technologists**: The GEA proposes several mechanisms that improve the visibility of geospatial activities. For example, developers will be able to peruse a catalog of applications to see how other agencies have solved a particular business problem. Developer points of contact information and a code library will be available to facilitate the exchange of solutions and ideas.

Consolidation poses several potential **risks** that could reduce the overall effectiveness and success of the consolidation program unless they are mitigated:

- **Line of business operations could receive a lower level of service than they currently receive**.
    - If GIS technologists no longer report into the Line of Business, they will develop an enterprise orientation and, over time, may lose their LOB process focus. GIS content expertise and other LOB institutional knowledge could potentially dissipate.
    - Application performance has the potential to be degraded when supporting infrastructure is consolidated. (i.e. There is risk that an enterprise data server that supports multiple agencies could perform slower than a server dedicated to a single agency.)
- **Enterprise resources, such as web image services, could be rendered ineffective if network capacity and other computing infrastructure are insufficient.**

GEA CONSTITUENCIES

There are four categories of constituents of the Geospatial Enterprise Architecture end state. Each has a unique set of characteristics that describe their business requirements, spatial data acquisition and distribution, and access to resources:

- **State Agencies** – Agencies and the Lines of Businesses (LOB) own the business processes that provide value added services to the general public, other government entities, and partners. The agencies are also responsible for the creation of authoritative statewide data layers that have many uses beyond the agency. Furthermore, state agencies often desire information from regional, county and local governments.
- **State Agency Partners** – Agency Partners, such as the Certified Flood Managers who support the Flood Decision Support System (DSS) in partnership with the state, generally have data and other working relationships with state government agencies, and often provide services to the general public.
- **Regional, County, and Local Governments** – Many geospatial data layers are created and maintained locally and have broad uses across all of the constituents listed here. For instance, county assessors have the responsibility for maintaining the definition of the county's property parcel data. Often these governments desire access to data from neighboring jurisdictions. An enterprise parcel data stewardship process could combine the data from 64 counties and make it available for download within a data clearinghouse.
- **Federal Government** – Federal agencies and programs often provide funding for state agency activities. These federal relationships are often both a funding mechanism and a consumer of GIS services. One example is the Federal Highway Administration (FHWA) who provides funds and consumes state generated road data. Another Federal Government constituent if the United States Geological Survey (USGS) who has provided important funding assistance under the Cooperative Agreement Partnership (CAP) program in support of both GIS Strategic Planning and GEA Business Planning.
- **General public –** Ultimately, the public is the primary beneficiary of state government. Many of the geospatial capabilities developed for a state government, such as a statewide geospatial viewer, would have broad applicability to the general public. However, there are a number of constraints ranging from data privacy to homeland security that restrict unfettered access to state data.

GEA DESIGN PRINCIPLES

The process of consolidation and the implementation of a Geospatial Enterprise Architecture is complex. There are many stakeholders and many input variables. To help guide this work, several design principles have been developed.

- **Focus on state requirements and internal/state facing services first.**

  The primary focus of the State's GEA work is to define a technical architecture that works for Colorado state government. State agency partners, other government entities, and the general public are secondary constituents that may eventually consume GEA services. Partners may eventually, in partnership with the state, define and contribute to common services and data. However, initial GEA service capability development will benefit state government. As the geospatial enterprise infrastructure and governance mature, the initially internal data and services can be made available, within use restrictions, to agency partners, other governments and the general public.

- **Develop coordination mechanisms for the entire geospatial enterprise.**

Coordination of geospatial activities throughout the enterprise is necessary to achieve consistently high levels of quality and performance and to reduce redundancies and costs. Coordination efforts should incorporate enterprise and LOB geospatial data development and acquisition, web service and application development, and administrative support functions. Enterprise GIS leadership and GEA governance are the primary mechanisms to achieve this.

- **Work within and extend existing OIT governance structures.**

  GEA will work closely with existing governance structures such as the Government Data Advisory Board (GDAB) to define geospatial data ownership, stewardship, and security. Geospatial data will be treated like other type of data for the purposes of defining these attributes and will ensure these attributes are stored along with other metadata within the geospatial clearinghouse.

- **Create separate infrastructures for state and public services.**

  It is critical that state agency work is not adversely impacted by public and other constituent access to GEA resources. This is especially true during significant events such as natural disasters. During a crisis, the ability of state agencies to perform should be minimally impacted by external pressures. State Agency Partners and their resources can be leveraged by the GEA as a mechanism for data and service distribution. The State Internet Portal Authority (SIPA) will provide reliable services and hardware infrastructure and management for eventual public access to state data and application services. SIPA is starting to act as a clearinghouse, allowing for public access to data download as well as display, and is considered a “state agency partner”.

- **Public services will have restricted access to geospatial data.**

  GEA services that are accessible by state agencies can deliver some restricted data while the public facing services would be outside the state firewall and would deliver an unprotected subset of the state-accessible data available to state agencies.

- **Enable scalability of geospatial capability**

  As the GEA develops, implementation decisions regarding infrastructure, governance, and data work flows should anticipate and plan for growth in demand for geospatial services overtime. A necessary first step is to measure the need and provide for existing demand.

- **Design for server virtualization**

  Virtualized servers offer flexibility when planning application rollouts and scaling capability to meet increased demand. All application and services providing geospatial capability should anticipate deployment in a virtualized server environment. Prototyping best practices should be employed for integrating new technology. Performance measurement and creation of test baselines will determine if certain applications should remain on dedicated hardware. Even if an application is deployed initially on dedicated servers, migration to virtualized environment should be built into future development.

- **Enable vendor diversification and encourage geospatial interoperability by avoiding vendor lock-in.**

  GEA investment decisions should recognize that new technology and new technology vendors will continuously emerge. An effective architecture is one that can grow over time and assimilate new technology and changes to business processes. An open architecture that can accommodate a range of vendor products will provide the greatest flexibility and maneuverability. One key to the success of a coordinated geospatial enterprise is the ability for its geospatial technical components to interact with each other seamlessly and without the need for customized interfaces.

Too much investment in a single vendor limits flexibility and may force sub-optimal (i.e. vendor proprietary) design and implementation decisions. The GEA should focus on the capability provided, not the technology used to deliver it. In this context, interoperability awareness and ease of integration are desirable considerations when making third party hardware and software selection. An enterprise perspective must balance the potential cost savings of open source technology with the coverage requirements of cross-training and development.

- **Build in measurement capabilities**

  When usage and performance metrics are gathered for a functional process step or an implemented technical capability, monitoring and management of capacity and utilization are enabled. Metrics capture, reporting, and analysis should be an operational requirement as each workflow step, or an application or service is designed.

- **Leverage the Internet and the World Wide Web**

  The interconnectivity provided by Internet based technologies can dramatically increase the accessibility reduce the support costs of both enterprise and agency line of business geospatial capability.

- **Achieve customer satisfaction**

  Customer satisfaction will be the ultimate measure of the effectiveness of the GEA. Every design, deployment, support, and management decision should consider the impact on the ultimate customer's satisfaction. Customer satisfaction criteria should be included when building usage and performance measurements.

GEA TERMINOLOGY

As a conceptual solution, this document focuses on the structure and organization of technical capability and the processes and policies needed to support it. This document is not a detailed specification for geospatial computing infrastructure; rather it is a **description of the elements** that should be considered for developing a geospatial enterprise architecture. After this conceptual architecture solidifies, then detailed specifications can be developed for implementation of the individual components.

Some key definitions of terminology used in the GEA are provided here. A glossary of terms used in this document and in the applications inventory can be found in the appendices of this document.

- **Functions versus Processes –** Functions are the logical groupings of individual processes, not people. A process describes the explicit work steps involved in performing a specific task. A process has a beginning and an ending point, while a function is ongoing operation. For example, the function "User Management" is an administrative unit that likely has an "Add User" process.
- **Authority/Decision Rights –** All functions need to have sufficient authority in order to be able to make the necessary decisions and to be effective. Colorado Senate Bill 155 has given the authority for geospatial consolidation to the State's CIO. Existing OIT governance structures, such as the Government Data Advisory Board (GDAB), are in place to provide guidance and advice to the CIO's office. These

structures can be expanded to include geospatial governance topics. These advisory committees can be responsible for developing and authoring policy recommendations for the CIO's approval.

- **Policy –** The rules and behaviors of a function are defined by its policies. A governance structure is responsible for determining a function's policies and overseeing compliance with these policies. Policies are only effective if the functions they define are monitored for compliance and those responsible for implementation are held accountable.

GEA MODEL ALTERNATIVES

The consolidation process will evolve individual agency-based geospatial activities into a single geospatial enterprise architecture with new **coordinated geospatial offerings**. This transition will require shifts in management focus from specific line of business capabilities and processes towards the more complex administration of enterprise infrastructure and supporting administrative functional processes. The geospatial community can benefit from OIT's expertise in managing large servers that support enterprise processes, and OIT can benefit from a mature geospatial user community.

Many of the GEA functions outlined below, such as systems administration, are already in place within OIT management functions. These resources can be utilized as the state's geospatial activities are folded into the OIT organization. In a similar way that the geospatial community can benefit from OIT expertise, there are also potential benefits that consolidation of geospatial activity can provide to the efficiency and effectiveness of OIT. This table lists some of the benefits that geospatial consolidation can bring to both the GEA and to OIT. Each of these benefits should be considered relevant to a consolidated geospatial enterprise.

Integrated GEA/OIT Consolidation Benefits
• Reduction in costs (software licensing, facilities, communications, personnel) • Standardized set of enterprise components, services, and data • Improved performance and shared funding • Common processes and methods refined through continuous improvement • Enterprise coordination of key services and capabilities, and events

Consolidation is being driven by a desire to **reduce the cost of providing geospatial capability to state government while expanding services**. A lack of geospatial coordination across agencies can lead to many unique solutions to similar problems. For instance, two agencies may choose to implement Automated Vehicle Location (AVL) capability using two different vendor technologies. The development of similar, but not identical, geospatial capability can lead to multiple instances of hardware, software, and human expertise resulting in an increase of overall costs.

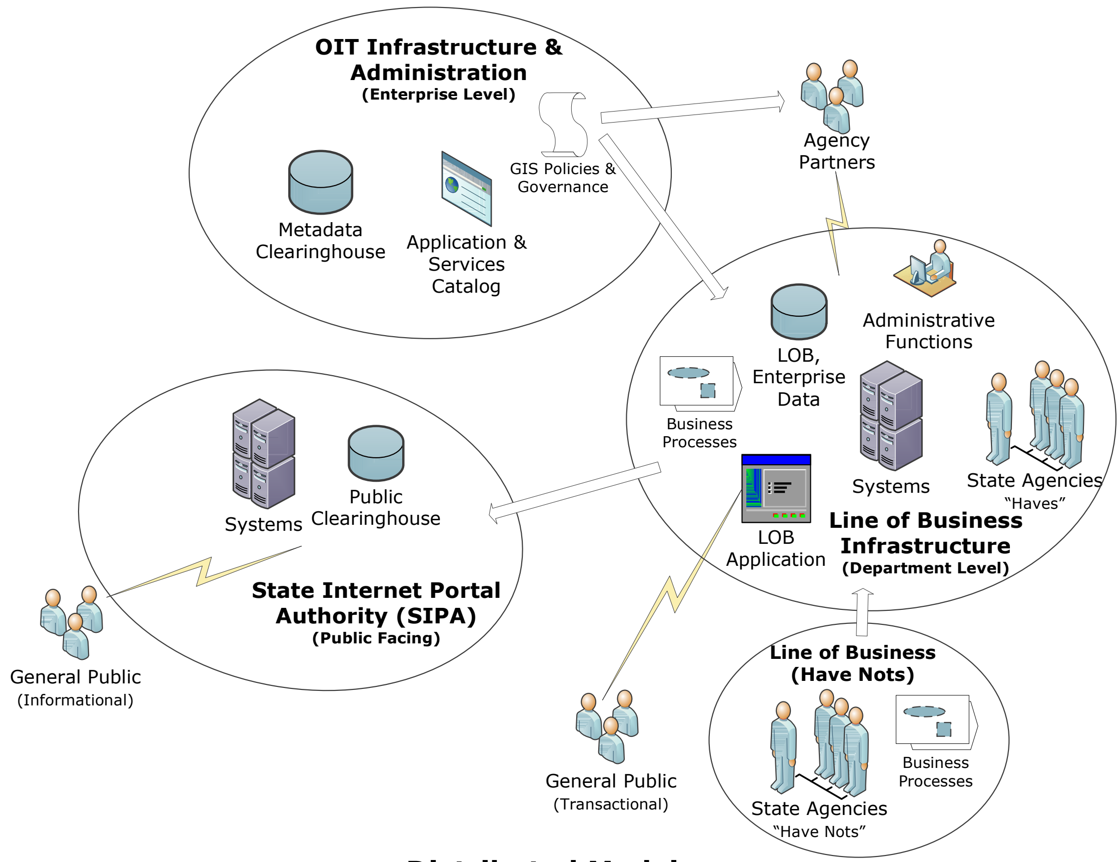
The following chart outlines some of the geospatial cost drivers to consider when making consolidation decisions:

GEA Cost Drivers
• Software licensing and maintenance fees • Software configuration / deployment and the impact on licensing fees • Applications server hardware • Spatial data acquisition and development • Storage and management of spatial data • System and database administration • Wait-time versus network capacity (LAN latency) • Support for multiple software packages providing the same function • Fail-over and load balancing capabilities • Service/data replication infrastructure and support costs

The applications and services inventory collection process – begun with this project – can grow into a full catalog of geospatial service offerings provided across the enterprise. This inventory can be used to make decisions about the specifics important to the Colorado GEA and to Colorado state agency lines of business. An understanding of the risks, benefits, and costs that are specific to Colorado can be used to build an enterprise architecture that uniquely serves Colorado state government.

Three different models for a geospatial enterprise are presented below. After two alternatives (Distributed and Centralized) are shown, the recommended Hybrid model is described.

DISTRIBUTED MODEL



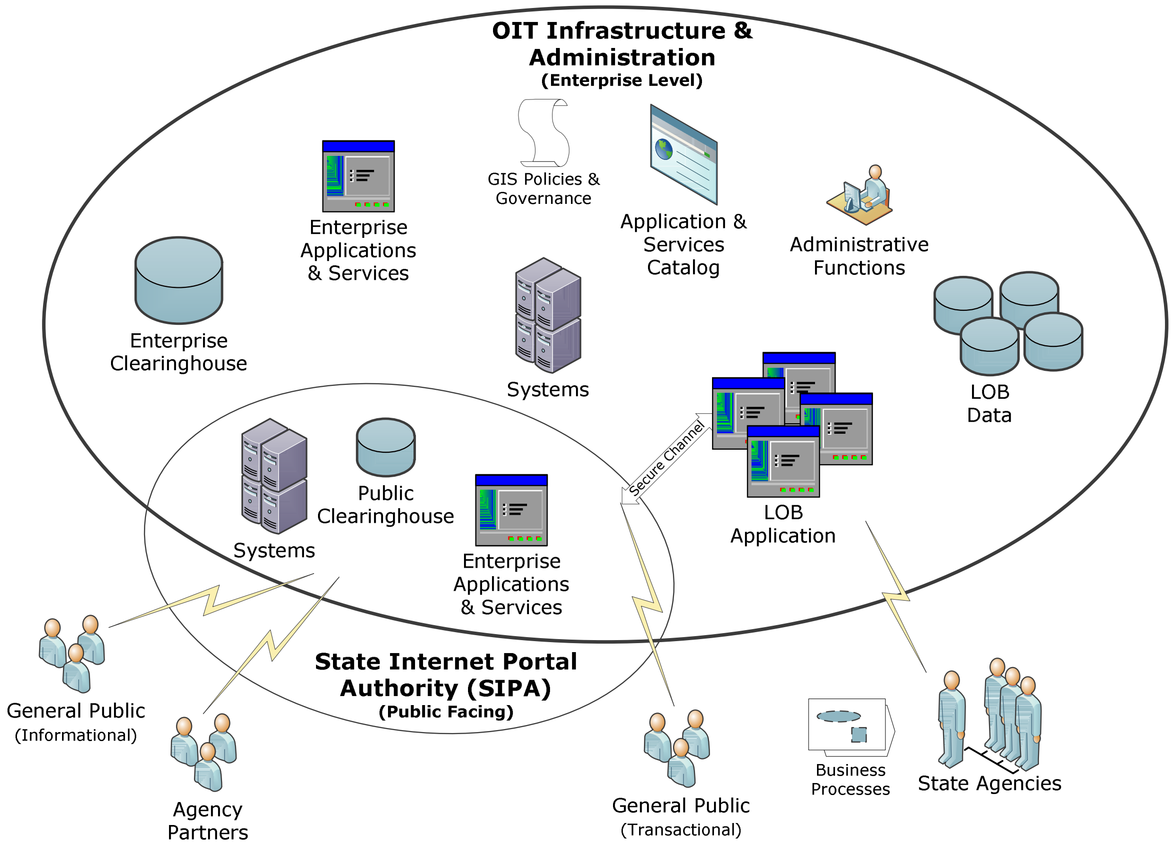
Distributed Model

- Geospatial governance and policy creation occurs within a single function under OIT. Individual agency representatives contribute to the governance process and are responsible for the promulgation of standards, best practices, and policies back to the agency Line of Business (LOB) and across the enterprise.
- Enterprise geospatial computing infrastructure and supporting functions are managed centrally.
- LOB geospatial computing infrastructure and supporting functions are managed by the LOB using policies set by the enterprise governance bodies. Agency LOB business processes are defined by the LOB.
- Agencies without resources develop relationships with other agencies to gain access to resources not offered by the enterprise geospatial organization.
- Applications and service development occurs at the LOB.

Distributed Model Advantages	Distributed Model Disadvantages
• Greater autonomy and customization for agency LOB • Computing resources are closer to the consumers where the work is performed • Distributed support functions can more closely aligned to specific LOB needs • Lower network capacity requirements	• Less coordination of implementation decisions • Increased excess redundancy (e.g. application servers) • Uneven distribution of resources across agencies • Distributed administrative support

• GEA can focus on enterprise offerings and policies while the agencies focus on LOB needs.	functions retain agency alignment slowing the adoption of centralized policies • Risk of non-adherence to enterprise policy

CENTRALIZED MODEL



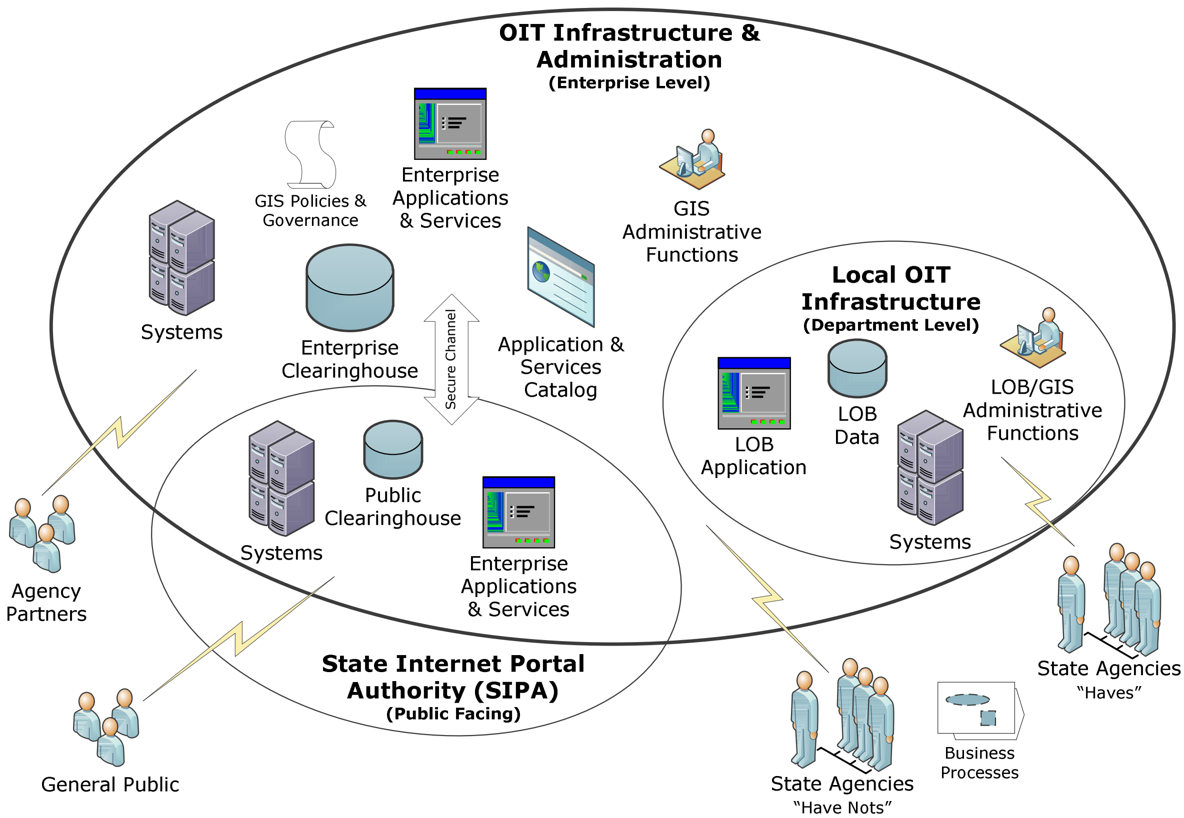
Centralized Model

- Geospatial governance and policy creation occurs within a single function under OIT. Agency representatives contribute to the governance process and are responsible for the promulgation of standards, best practices, and policies back to the agency Line of Business (LOB).
- Both enterprise geospatial as well as agency line of business computing infrastructure and supporting functions are managed centrally by OIT using policies set by the enterprise governance bodies. There is no geospatial computing infrastructure within the agencies.
- Agency LOB business processes are defined by the LOB.
- All agencies gain access to common resources offered by the enterprise geospatial organization.
- Applications and service development occurs at a central location.

Centralized Model Advantages	Centralized Model Disadvantages
• Single top-down process for defining and delivering geospatial services	• OIT offerings are not tailored to LOB needs

• Computing resources are optimized within data centers • Support functions have a single reporting structure leading to delivery consistency and policy adherence • OIT efficiencies and policies quickly are accessible to LOB applications and data	• Performance metrics harder to achieve • Higher network capacity requirements • Centralized support functions may not identify with LOB "customers" • Perceived imposition of OIT policy into LOB business processes

HYBRID MODEL (RECOMMENDED)



Hybrid Model

- Geospatial governance and policy creation occurs within a single function under OIT. Agency representatives contribute to the governance process and are responsible for the promulgation of standards, best practices, and policies back to the agency Line of Business (LOB).
- Enterprise geospatial computing infrastructure and supporting functions are managed centrally by OIT.
- Agency-based geospatial computing infrastructure and supporting administrative functions are managed by OIT and described in the GEA Offerings section of this document. The location and optimization of technical and human resources is based on OIT Enterprise Architecture policy.
- Agency LOB business processes are defined by the LOB.
- OIT is responsible to ensure that all agencies have access to a common set of enterprise resources.

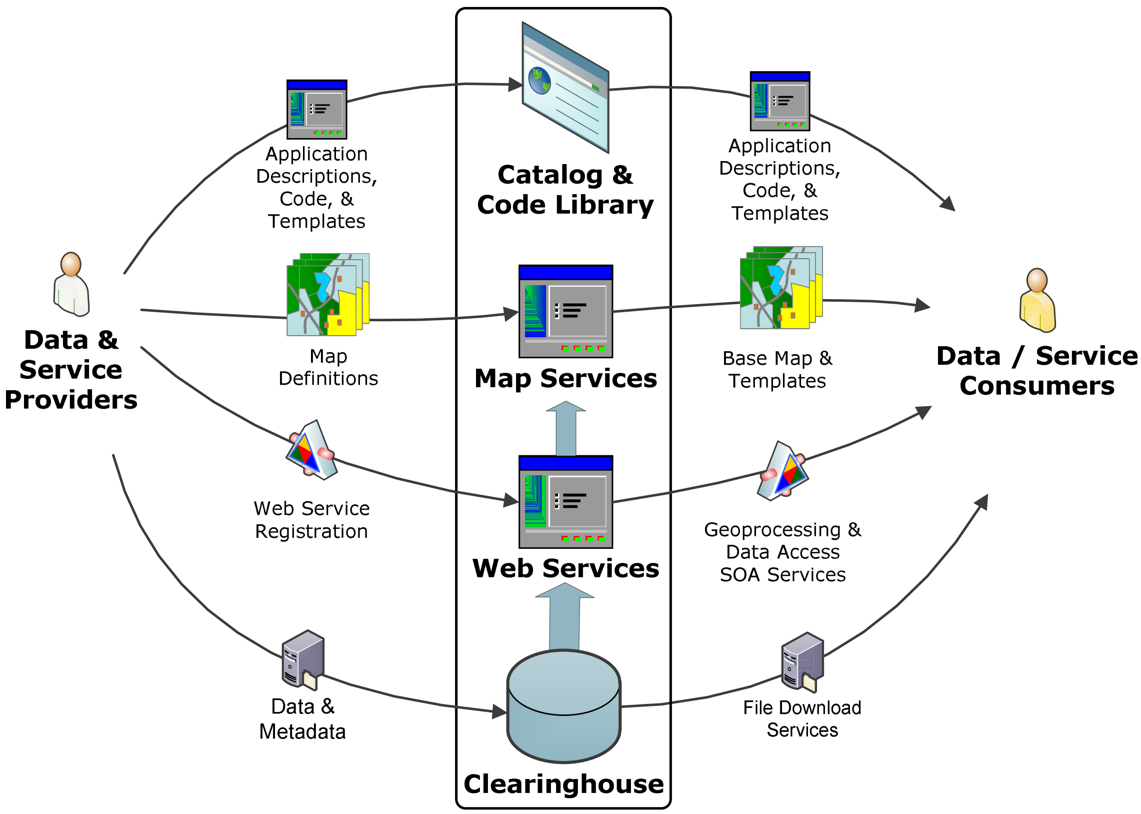
- Applications and service development to support Line of Business process requirements is guided by OIT policy by personnel who may reside at the LOB. Sensitivity to the success of the LOB applications, business processes, and mission while promote the success of the GEA. Geospatial human resources are encouraged to network and work on enterprise solutions and other agency projects where they have expertise even though they may seemingly be dedicated to a single LOB.

Hybrid Model Advantages	Hybrid Model Disadvantages
• OIT and LOB partnership defines need and delivers solutions • Computing resources and network capacity are optimized across the entire enterprise • Embedded OIT support functions can aligned to specific LOB needs while adhering to OIT policy	• Effective implementation of dispersed administrative functions requires effective communication practices • Potential for sub-optimal hardware utilization and uneven distribution of resources across agencies • GEA must provide an expanded set of enterprise offerings that meet LOB needs than the distributed, agency-based model.

GEA OFFERINGS

The Geospatial Enterprise Architecture facilitates the efficient coordination of geospatial activity and flow of geospatial data across the enterprise. This section describes the **administrative and technical work** necessary to achieve these goals.

The following diagram outlines the technical components and flow of information into and out of the enterprise architecture. In addition to the technical infrastructure for providing access to geospatial data and services, the GEA must also provide the policies, standards, and processes to define the geospatial infrastructure.



GEA offerings can be categorized into either Technical Services or Administrative Functions. Many of these offerings build and manage the geospatial enterprise infrastructure, but they are also available to support the agency lines of business processes. For example, the GEA can provide an enterprise geocoding service which may provide capability to all consumers in state government and also provide services to assist the geospatial enabling of an existing LOB application.

Technical Services – The capabilities provided by the GEA include the physical computing hardware and the applications and services that they provide.

- **Applications and services catalog –** The catalog maintains an inventory of applications and services that are in production, or are actively being developed. This catalog also provides a shared code library function that can be accessed by developers to encourage the reuse of existing code.

- **Enterprise data clearinghouse –** This is a logical collection of authoritative enterprise data that is populated and refreshed through the data stewardship process. While the data included in the clearinghouse could have an enterprise or agency partner steward, it is probable that most stewards will be line of business process owners.
- **Enterprise applications and services –** The GEA will maintain an inventory of applications, web services and supporting application server software/hardware. These enterprise services will provide a variety of geospatial capabilities.
  - Map services
  - Enterprise web services
  - File download services
  - Web applications
  - Desktop application services
  - Data and application hosting

Administrative Functions – The Geospatial Enterprise Architecture requires more than the technical components that provide the store the data, perform geoprocessing, and display/create maps. There are many administrative functions necessary to design, build and support the geospatial technical infrastructure. Administrative functions include a range of tasks from non-technical procurement and contracting, to the technical tasks of system and server management, applications / services development and project consulting.

- **Enterprise Geospatial Coordination**
- **Geospatial Project Management**
- **Application and Service Development**
- **Enterprise Purchasing / Contracting**
- **Spatial Software License Management**
- **System and Server Administration**
- **Customer Satisfaction**

The next sections of this document outline each of these administrative functions and technical services in greater detail. After each offering description some of the requisite policies, standards, and processes are noted.

APPLICATIONS AND SERVICES CATALOG

A catalog of enterprise and LOB geospatial applications and services will create an enterprise wide forum for **sharing geospatial expertise and promoting awareness of geospatial projects**. The LOB geospatial applications and services inventory collected for this project should provide the foundation for a catalog that has the following characteristics:

- Provides a view into geospatial development capability across the Colorado state government enterprise for the purposes of identifying active and previous geospatial projects and to encourage the sharing of expertise be GIS professionals across the enterprise.
- Facilitates the identification of existing and (potentially planned) geospatial applications and components suitable for reuse.
- Identifies existing applications and services that are potential candidates for enterprise executed and/or managed services.

- Encourages communication within the geospatial community. GIS technologists can find others who are already working on a particular topic (e.g. automated vehicle locators).
- Allows for sharing of pieces of functionality/code from applications developed among state agencies. This could take the form of a reusable code library.
- The catalog could include a UDDI registry that identifies available SOA web services and their access methods.

POLICIES, STANDARDS AND PROCESSES

- Geospatial Application Testing and Benchmarking Standardization - Define the metrics and process for testing and performing quality assurance on geospatial applications. This can provide a common set of definitions that can be used to describe entries in the application and services catalog.
- Field Application Implementation – Define the best practices, recommended software, and hardware (e.g. GPS) for field mapping and data collection applications.
- Geospatial Application Development Standards – Defines the best practices and development standards applied to all enterprise geospatial development.

CLEARINGHOUSE

An enterprise data clearinghouse is a set of infrastructure and related processes that can provide several data related functions:

- **A metadata clearinghouse** – A metadata (data about data) clearinghouse allows the consumer to query the clearinghouse to discover what data is available; evaluate the data's origins and quality. For instance, footprints of aerial imagery can be included in the clearinghouse for browsing to help the consumer determine the available imagery for a given geographic area.
- **The authoritative source for enterprise data** – The data governance process identifies a data steward for each enterprise data layer. The stewards are responsible for defining the data development, management, and publication of the enterprise data layers. Data is created in either local or enterprise level repository to support the agency line of business processes. Periodically, these data (and appropriate metadata) are published to the enterprise data clearinghouse. Consumers within the stewards department or across the enterprise can use various data access services (e.g. File download, or web service) to retrieve the data.

POLICIES, STANDARDS AND PROCESSES

The clearinghouse is much more than a data storage and access infrastructure. Effective organization and appropriate policy development are necessary to **make the enterprise clearinghouse the "go to" place** for geospatial data within the State of Colorado. Policies necessary to support clearinghouse operations include:

- Geospatial Data Management – Describes the policies, standards, and best practices for geospatial data management including:
    - Standards that have been adopted
    - Recommended best practices for data development, access, and use
    - Geospatial meta data management: how used, minimum requirements

- Approved geospatial data formats
- Restrictions exist on data transfer
- Quality control and clearinghouse import procedures

- Geospatial Data Security & Access – Defines the level of access for each constituent group and outlines the access constraints that must be considered when adding new data to the clearinghouse. For instance, a clearinghouse policy might state that only enterprise data approved for public distribution as defined by the data governance stewardship process and will be hosted by SIPA. Specific considerations should be made for legislation regulations and access to third party, including:
  - Health Insurance Portability and Accountability Act (HIPAA) – Data privacy
  - Homeland Security (HLS) exemption (e.g. Water Sources)
  - Broadband and other utility proprietary information protection
- Geospatial Data Governance – This policy defines the geospatial data stewardship process and standards for enterprise data layers. This policy also outlines the interactions and shared responsibilities with the Government Data Advisory Board (GDAB) as relates to geospatial data.
- Monitor and Reporting – Defines what is measures, how often data is samples, and outlines the process for analysis and distribution of results.

ENTERPRISE APPLICATIONS AND SERVICES

Enterprise applications and services is a broad category that contains a number of service types that are accessible by directly by GIS consumers, or through GIS and business applications. **The GEA supports LOB business processes** by providing enterprise applications and development services at both the enterprise and agency LOB levels.

MAP SERVICES

- Enterprise map services provide enterprise base map data in multiple formats suitable for different business processes.
- These map services can be used in multiple application settings (e.g. LOB applications, enterprise browsers) to achieve a standardized presentation of Colorado geospatial data.
- The services available can be tailored for specific uses. For instance, 3rd party maps are available and optimized for performance, but they don't allow for state-defined symbology and use of state authoritative data.
- A library of standardized map templates can be an efficient method to provide an enterprise level tools that could be broadly accessed. These templates could provide the symbology and pointers to enterprise base map data which the GIS analyst can add departmental data for relatively quick and standardized production of presentation grade paper and PDF maps. These services could be delivered to desktop GIS users via remote tools such as Citrix.

ENTERPRISE WEB SERVICES

- GEA Web services can be described in one of two types:
  - Data web services (including imagery) deliver data for a specific geographic extent.

- Geoprocessing web services provide geocoding (address location) and other value added services such as vehicle routing.

- Both of these web service types can be designed such that they are accessible by transactional and reference applications at either the enterprise or LOB levels. Additional simple browser based interfaces can be created for direct end-user access to the web services. For instance, a simple web page can be created that accepts an address, calls an enterprise web service and returns the locations X/Y coordinates.
- The web service infrastructure should have built in redundancy for fail over and load balancing.
- Various levels of need/accuracy for geocoding services exist across the agencies. A detailed needs assessment for geocoding/addressing will identify requirements determine which/how many reference systems are needed.
- Services can be incorporated into applications that support complex data governance processes such as interactive QA/QC of addresses of a state master address file.
- An historic imagery archive service can maintain all current and future imagery. Past imagery that has been digitized can be included as it becomes available.
- In addition to web-services and file download capability, an upload capability should be considered for collection of non-enterprise imagery data (e.g. forest service fire fighting location imagery)

FILE DOWNLOAD SERVICES

- In order to maximize the efficient access to enterprise geospatial data in the clearinghouse, a standard set of data access services can be managed by the GEA and made available across the enterprise. In addition to web services, file download capability, such as FTP, will be offered.
- These services can initially be made available to only state agency consumers. As resources become available and the capacity increases, these can be more broadly accessed by partners and the general public.

WEB APPLICATIONS

- Web based GIS spatial data browsers are an effective tool for access to GIS data for both GIS professionals and by non-GIS professionals.
- The standard browser template can be created by the enterprise developers.
- This template can be used as the basis for multiple LOB applications. Colorado enterprise map services can provide the base map layers and LOB data can be added to support specific business processes.
- This template can also be used as the basis for an enterprise level Colorado spatial data browser. This browser could also be integrated with the clearinghouse for browsing and downloading of enterprise spatial data

DESKTOP APPLICATION SERVICES

- There is a large installed base of existing geospatial desktop applications. Initially, these need to be supported as is. Eventually, these applications and desktop environment can migrate to an enterprise services based environment. This can be accomplished buy the use of virtual desktop tools such as Citrix. Key to undertaking this activity is to be able to architect the applications in a manner that considers the value of the distribution model, where these applications provide the most value and who needs to access them.

- A standard set of geospatial desktop applications, such as ArcGIS Desktop, can be made available using virtual desktop software such as Citrix.
- Map templates and toolbars for ArcGIS can be developed as a value-added service by GEA staff for desktop users via Citrix.
- Administrative and operational efficiencies can be increased by using a virtual machine environment that supports desktop applications rather than management of individual LOB desktop software installations.

DATA AND APPLICATION HOSTING

- **Spatial application hosting** – Large economies of scale can be realized by consolidating spatial application and map servers. Providing common environments and expertise at the enterprise level will enable the LOB operations to focus on their core business processes, not the technology necessary to support them.
- **Non-enterprise central data repository** – Agencies may periodically need to publish a read-only version of data that is useful to other agencies, but is not deemed to be at the enterprise level. The clearinghouse can serve an additional data distribution function by allowing agencies to store data in the repository for their own distribution needs.
- **Central working data hosting services** – Smaller agencies with few geospatial resources, the "Have Nots", have a need for shared access to a enterprise data hosting services to store and edit data. The enterprise data clearinghouse could provide LOB level capability for agencies that do not have access to local data storage. In order to provide this service, then network bandwidth between the agencies and the clearinghouse must be sufficient to accommodate larger volumes and performance appropriate for transaction oriented systems.
- **Server performance and network monitoring** – The determination of the effectiveness of a service oriented hosting environment depends on acquiring the information that can provide situational awareness and foster fact-based decision making.

POLICIES, STANDARDS AND PROCESSES

- Level of Service Policy – Defines sets measurable level of service specifications regarding: number of hits, bandwidth, refresh rates, etc. Image display speed should be the most important performance metric of this service.

ENTERPRISE GEOSPATIAL COORDINATION

This broad communication function ensures that all geospatial stakeholders are informed about the goals and methods of the GEA. All geospatial activity throughout the enterprise needs awareness of available resources. Two key areas for coordination in Colorado are **data stewardship and applications/services development**. There is much work going on in the state, to understand who generates and consumes geospatial data within state government. These data governance beginnings, such as the GIS Data Governance Working group, need further development and coordination within the overarching OIT governance. Identifying the appropriate data stewards, recognizing the potential data consumers and compiling data development best practices will help reduce the occasional redundant data management and lessen the need for frequent derivative data development processes. Coordinated enterprise data management will reduce storage requirements and promote data awareness and improve quality. Geospatial developers, who may be co-located within the LOB organizations, can benefit from awareness of geospatial development projects in other parts of the enterprise.

Contracted developers will produce a greater return as policies and practices mature from coordination efforts. The coordination function can promote the use of the applications and services catalog, and coordinate development activity to prevent similar web services from being created in different parts of the enterprise.

It is important to recognize the distinction between larger agencies with mature GIS organizations, such as CDOT and DNR, who have strong existing GIS Programs and other agencies that are not yet utilizing the full potential of geospatial technology. Governance, coordination, and consolidation activities must understand the varying levels of constituent capability and create policies that support existing as well as developing geospatial infrastructure and workflows.

- **Setting and promoting the use of standards and best practices**. The coordination function can draw experts from across the enterprise to identify options and define a set of geospatial standards to be used across the entire enterprise.
- **A process to create and promote access to clear and concise documentation**. Documenting the work of the coordination function is critical to its effectiveness, including agreements and understandings on data stewardship and applications/services development.

POLICIES, STANDARDS AND PROCESSES

- Geospatial Advocacy and Resources – Under OIT, the GEA Coordination function defines who is responsible for advocating the use of geospatial technologies within the organization and working with end users to embed geospatial technologies within department programs and services, and what resources are available to the organization to assist in the adoption, usage, and support of geospatial technologies.
- Geospatial Data Acquisition and Coordination – Defines the process for determination of geospatial data requirements and the process to acquire or develop new data sources. This policy outlines who is responsible, accountable, consulted and informed for pre-acquisition review, acquisition and/or development of geospatial data.
- State of Colorado Geospatial Management Authority – Defines the policies, funding responsibilities, decision rights, and scope of influence for each of the geospatial activity within OIT.
- Enterprise Geospatial Strategic Plan Development – The GEA Coordination function is responsible for developing, vetting, ensuring funded, and approving all enterprise wide geospatial strategic planning for the State of Colorado.
- Geospatial Architecture – Defines the geospatial reference architecture used to guide the development of geospatial capabilities and the server infrastructure to support them.
- Enterprise Geospatial Project Approval – Defines which projects need approval, identifies the approvers, and outlines the approval and prioritization process for an enterprise geospatial project.
- Geospatial Technology Standards – Define what geospatial hardware and software technologies are approved for deployment and use within the enterprise. Defines what maintenance approach will be used for geospatial technologies.

GEOSPATIAL PROJECT MANAGEMENT

The GEA can maintain project management and project consulting expertise and related process expertise for management of both enterprise and LOB geospatial projects. All types of geospatial projects can be supported: **data development and acquisition, consolidation, and geospatial strategic planning**. Projects that do not clearly fit elsewhere could be addressed in this context.

POLICIES, STANDARDS AND PROCESSES

- Project Request Procedures and Terms – Defines the project management service offering and outlines the responsibilities of both the GEA and the requester.

APPLICATION AND SERVICE DEVELOPMENT

This development function incorporates all aspects of applications and web service development from requirements gathering, through applications and design build, and onto deployment. The geospatial applications and services could support either enterprise or agency line of business processed. Development activities could include the spatial enabling of existing enterprise and LOB applications as well as integration of spatial applications.

POLICIES, STANDARDS AND PROCESSES

- Geospatial Service Development – Defines how to determine need and coordinate the development of new geospatial services and applications across the enterprise.
- Geospatial Technical Application and Service Standards – Describes approved standards for enterprise geospatial application development. This includes adoption of industry standards, such as, the Open GIS Consortium (OGC) web service standard.
- Application Development, Mapping, and Geoprocessing Best Practices – Defines the GEA adopted application development best practices and recommendations for geospatial mapping such as layer naming and cartographic representation.

ENTERPRISE PURCHASING / CONTRACTING

A common enterprise wide procurement process for managing the purchase of geospatial software and data using **standard contracting language** will ensure that enterprise GEA policies are implemented and that. For example, a common process should require that all purchased data be licensed for use by all state agencies.

POLICIES, STANDARDS AND PROCESSES

- Geospatial Procurement –Defines the procurement process and administrative rule for the purchase of geospatial software and support.
- Geospatial External Consulting Services – Defines how external geospatial consulting services are specified, selected, and acquired. Some individual agencies, such as CDOT, already have established geospatial consulting procurement process which will need to be considered when developing similar processes at the enterprise level.

SPATIAL SOFTWARE AND LICENSE MANAGEMENT

In addition to administrative support and management of a license server, this function also manages the selection, procurement, deployment, and **version control** of desktop and server geospatial software.

POLICIES, STANDARDS AND PROCESSES

- Approved Software Standards – Defines the set of geospatial server and desktop software that is approved for use and support on OIT equipment.
- Software Acquisition Policy – Defines the process to acquire new versions, upgrades, or licenses for approved software.

SYSTEM AND SERVER ADMINISTRATION

This broad category includes a number of specific functions that are a shared responsibility between GEA geospatial practitioners and other traditional IT practitioners. These include:

- Server operating system management for geospatial applications and database servers
- User management
- Disaster recovery and backup
- Spatial database management (i.e. ArcSDE management)
- Data layer maintenance management (e.g. periodic analysis for index optimization, etc.)

POLICIES, STANDARDS AND PROCESSES

- Geospatial Technology Approval Process – Defines how technology standards are researched, identified, vetted and approved.
- Geospatial Technology Waiver Process – Defines how to acquire approval for technologies that are not currently on the approved technologies list.

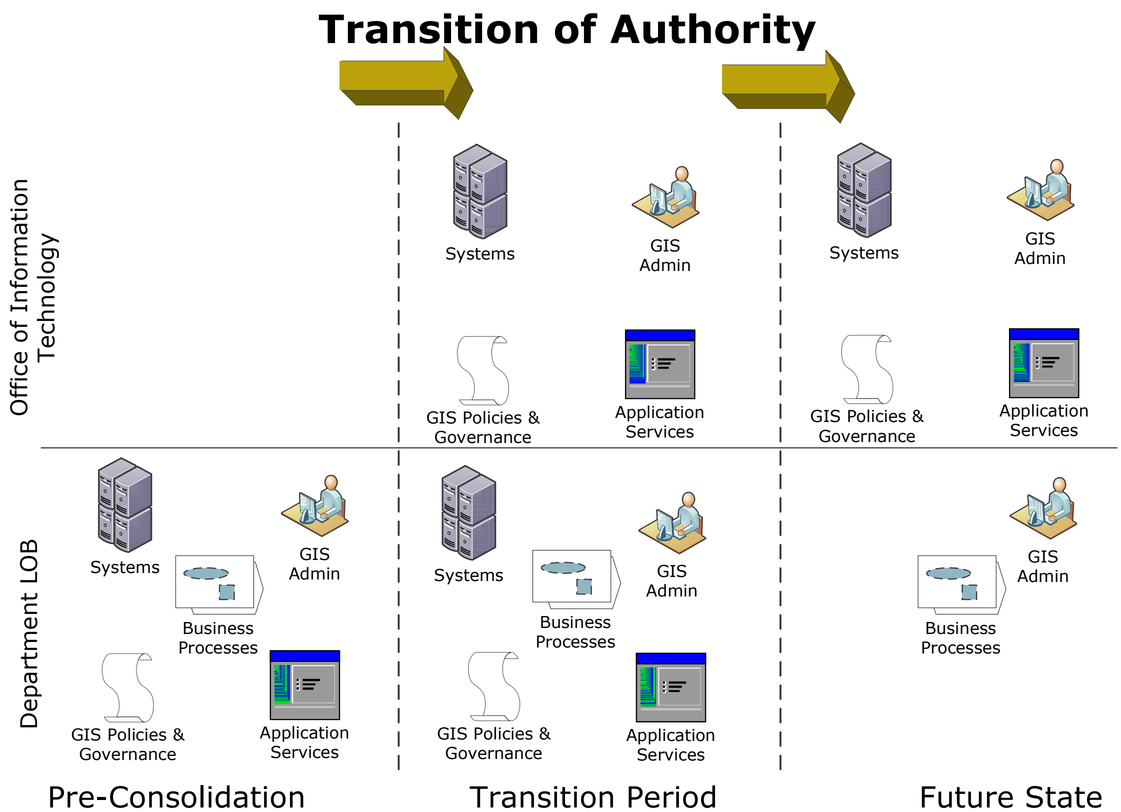
CUSTOMER SATISFACTION

Customer satisfaction will be the measure of success of the GEA. Metrics that measure technical **performance and service request responsiveness** will enable the GEA to monitor its service levels and to make informed changes to increase overall effectiveness. Existing OIT Service Management Agreements with departments should be expanded to include geospatial performance levels.

POLICIES, STANDARDS AND PROCESSES

- Technical Service Performance and Measurement Policy – Defines what is measured, how it is analyzed, and how these measurements are used to adjust performance.
- Customer Support Practices – Outlines what the customer satisfaction function is, what support services are provided, and defines the customer satisfaction goals for the function.

TRANSITION STRATEGY



This diagram describes the potential transition of authority from independent agency model into a coordinated enterprise model. Note that this **diagram does not imply the specific location of any resource**; it is intended to show the migration of authority for the components that comprise the enterprise infrastructure.

PRE-CONSOLIDATION

- Departmental Line Of Business (LOB) does everything without central authority or control

TRANSITION STATE

- OIT is organizationally responsible for everything including GIS related: Geospatial desktop and server system infrastructure and administrative functions (GEA Offerings), and governance and policies (GEA Authority)
- Departmental LOBs continue to maintain and manage the departmental work processes and define geospatial requirements.
- Geospatial application development/deployment and GIS server administration (e.g. Map Services) are co-managed between the LOB and OIT using a common set of processes and service levels.
- During this timeframe integration with GEA infrastructure, data, and services begins
- Initial GEA governance begins with defined scope and charter which may be expanded over time

- The development of methods to coordinate geospatial activities that have enterprise impact is introduced. Data workflows and other geospatial activities that span agencies or functions across the enterprise such as address management and geocoding are the types of candidates to consider for enterprise coordination.
- OIT acquires a growing sense of ownership and begins to develop geospatial governance structures and delegated authority. OIT geospatial policies are written considering line of business need for responsiveness to their funding (e.g. federal health grants) or agency mandates.
- Economies of scale are realized as some redundancies and unnecessary efforts are reduced based on quantifiable decision criteria.

FUTURE STATE

- OIT provides infrastructure and services including
    - System Administration
    - GIS Server Management
    - GIS Application Development
- Departmental LOBs focus on the core work of their business processes
- GIS governance fully established under OIT; LOB maintains local GIS administrative policies within OIT parameters.
- Full enterprise coordination of all geospatial activities with the defined enterprise scope

TECHNOLOGY CONSIDERATIONS AND PRIORITIZATION

This section of the document provides some technology consideration as future tasks and other activities are undertaken during implementation of this plan. The following assumptions are made for these technology considerations:

- Regardless of the location of components, GEA/IT operational level management activities will be handled through a centralized organization. Operational level management includes maintaining availability consistent with service levels, capacity planning, system and component monitoring, operating system and database maintenance, and change management.
- Geospatial technical and administrative activities outlined in the offerings section of this document will be handled through a **combination of both centralized and local organizations** consistent with well defined responsibilities.

Technology considerations are as follows:

- **Definition of Metrics for Consolidation Decision Making –** In order to facilitate use of the most cost effective geospatial infrastructure, components should be consolidated whenever possible. Geospatial application components include server infrastructure such as map, data, applications and web servers as well as discrete application components that can be easily repurposed such as web services and generic web-based geospatial viewers. Although consolidation of the infrastructure into one or morecommon locations is not an absolute requirement, such consolidation will likely result in further lowering of costs. However, **there are times when distribution of components makes sense**. A checklist of component characteristics should be developed to guide the determination of which existing geospatial application components are candidates for consolidation and which components should remain distributed within the line of business.

  The metrics for component consolidation decision making should include both technical and logistical considerations. The application inventory process – begun with this project – can be used as an input to the application consolidation/distributed decision making process. Here are some factors that should be considered:

  - **Line of business operation continuance** – Will consolidation negatively impact LOB responsiveness to its mission?
  - **Consolidation benefits** – What are the measurable benefits that consolidation can provide to the Line of Business?
  - **Network connectivity and capacity** – Is there enough bandwidth to support the application if it is moved outside of the LOB location?
  - **Application life cycle stage** – If an application is approaching end-of-life, is consolidation warranted?
  - **Technology of application (investment versus divestment)** - The return on further investment in technologies that our being phased out, such as ArcIMS, should be measured in the context of overall portfolio management.
  - **Potential of application to provide an enterprise capability** – Can an application or service be repurposed to support a larger enterprise wide constituency?

- **Cost of migration** – How much will it cost to move the application into an enterprise infrastructure?
- **Cost of support** – How much more (or less) will it cost to support this application within OIT?
- **Currently implemented technologies** – Is the technology used in the application used in other parts of the enterprise? Can economies of scale lead to cost reductions?

GEA Technology Platforms in use (Compiled from applications/ Services Inventory)			
○ .NET	○ ERDAS Imagine	○ HPAC MapInfo	○ SQL-Server Express
○ ArcPad	○ ESRI ArcGIS	○ MapServer	○ Surfer
○ AutoDesk MapGuide	○ ESRI ArcGIS Server	○ MS Access	○ Sybase RDMS
○ AVG	○ ESRI ArcIMS	○ MySQL	○ WMS
○ CAD (Dispatch)	○ ESRI ArcSDE	○ Oracle RDBMS	
○ CADD	○ ESRI Image Server	○ PostGres/PostGIS	
○ Cold Fusion	○ Google Maps GPS	○ SQL-Server	

- **Network Bandwidth Analysis** – There is no one set of rules that guide the deployment of geospatial components. Before the implementation of any new geospatial system, rollout of a new feature class, or migration of geospatial components or data from one location to another, the State of Colorado should undertake a Network Bandwidth Analysis activity using line of business requirements as the foundation to determine component placement. If this is not done, there is significant risk that the performance of geospatial applications /services and potentially other networked applications may not achieve their required service levels.

  There are three primary **considerations to this network analysis**:

  - The frequency of access
  - The size of the data transferred
  - The location of the originating request

  These three attributes must be considered in light of the defined performance requirements of the application. Often, geospatial applications do not involve real-time transactions, yet might have high data access volumes. There is also an important distinction to be made between data editing and data warehousing. Much GIS technology tends to be focused on the former rather than the latter, leading to performance issues when supporting multiple applications.

  Performance levels must be carefully considered on a per application basis, in order to determine the actual performance requirements for a given geospatial application. **Common valuation techniques** should be used to evaluate the bandwidth trade-offs for each application. A few examples include:

  - Collect the initial set of requirements as defined by the line of business
  - Define a baseline of existing network capacity to determine difference between existing capacity and collected requirements
  - Perform a what-if analysis of the loss of business value (e.g. increased costs, reduced service, risk to state personnel or constituents, etc) by using less than optimal response times

This will help arrive at more realistic set of business performance requirements. Such business requirements should be tested for business value otherwise the organization may end up with optimized service as opposed to required service.

These are integrated considerations and must be weighed in an inter-dependent manner. For example even through components may house enterprise data or services which might ideally be suited to centralization, the performance requirements for service or data access may preclude locating the components in a centralized location. It may need to be replicated at multiple sites or positioned at the site with the largest % of usage.

Before undertaking the migration, the State of Colorado should whenever possible, **collect the usage requirements** (who will access the information, where from, the frequency of access) and then empirically measure the bandwidth used by the geospatial application (or the standard application using geospatial data). If empirical measurements are not readily available, estimations can be made, but both latency and performance metrics should be required.

Below are some factors to **evaluate various bandwidth requirements and costs** for each agency. These can be used to experiment with alternative network link types (bandwidth capacity) and to understand the costs of changing bandwidth and to assess the net value of improved response times.

- Required Service Level Response Time (90% within XX seconds)
- Average Transactions/Transfers per Hour (#)
- Peak Transactions/Transfers per Hour (#)
- Average Size of Transfer (MB)
- Network Link Type (type)
- Speed of Link (MB / sec)
- Current Bandwidth (MB/Hour)
- Existing Link Usage (in %)
- Cost of Bandwidth (full monthly cost in $/month)
- Total Bandwidth Required (MB/hour)
- Bandwidth Available Per Second (MB/ sec)
- Individual Transaction Response Time (seconds)
- Average Bandwidth Utilization (in %)
- Total Facility Bandwidth Utilization (in %)
- Cost of Providing the Service per Transaction ($/transaction)
- Total Network Cost of Application ($/month)
- Predicted Response Time Compliance (seconds: + good, - bad)
- Management Cost (estimated costs) ($/month)

- **Virtual Desktops** – Most desktop application can be moved to the “enterprise cloud” by installation on a centralized server and making it available through remote virtual desktop tools such as Citrix. The obvious benefits are fewer installation /configurations for OIT to manage; desktop standardization; much less desktop support; more complete access to map templates and data. Essentially, the ideal virtual desktop environment can be tailored to meet the needs of a specific type of user (e.g. mapmaker, casual viewer). Implementation of remote virtual desktops requires extensive planning, configuration, testing, prototyping, and initial support. The issues that are often raised about virtual desktops, such as difficulty working with heavy graphic images (millions of colors) and inadequate response time can be overcome with managed execution, proper configuration and adequate server capacity. For some small set of high end applications a virtual desktop may not be viable (e.g. traffic modeling and some highly specialized mapping and analysis). For many geospatial applications, virtual desktop tools provide adequate "good enough" capability.

- **Monitor geospatial industry trends** – This list is not intended to be comprehensive, but rather, it identifies some key trends that are impacting geospatial technology and should influence GEA implementation and coordination decisions:
  - Location-based services
  - Mobile applications
  - Crowd-sourcing
  - Server virtualization
  - Cloud-computing
  - Authoritative Data concepts
- **Other Best Practices and GEA implementation considerations:**
  - Demonstrate how OIT can bring expertise and commitment to the table. (e.g. Demonstration projects)
  - Continue application inventory data collection and convert the data and process into an on-going geospatial application and service catalog offering.
  - Define and implement a set of quick wins to establish fundamental GEA capabilities (e.g., map template library)
  - Establish a volunteer start-up team to define and implement a GEA functions (e.g. CO base mapping services)
  - Build rapid prototypes of initial enterprise services such as geocoding
  - Conduct repository staging and performance testing

POLICY CREATION & GOVERNANCE

The consolidation process provides the opportunity to develop high quality and consistently delivered geospatial services, technical capability and data for all consumers across the enterprise of Colorado state government. However, technical capability alone is not sufficient to achieve this goal. The specific scope, decision rights and responsibilities of each of the GEA functions and service offerings described above must be defined and cross referenced to ensure that no overlaps or conflict occurs. Inevitability, some conflict will occur, in which case there should be procedures to achieve resolution. As these policies are completed, processes are designed and developed to guide the workflow between organizations.

The GEA is also responsible for the **coordination of geospatial related activities across governance committees**. Clearly articulated policies and well understood processes that are defined, supported, and communicated by a coordinated governance structure are required for an effective geospatial enterprise architecture.

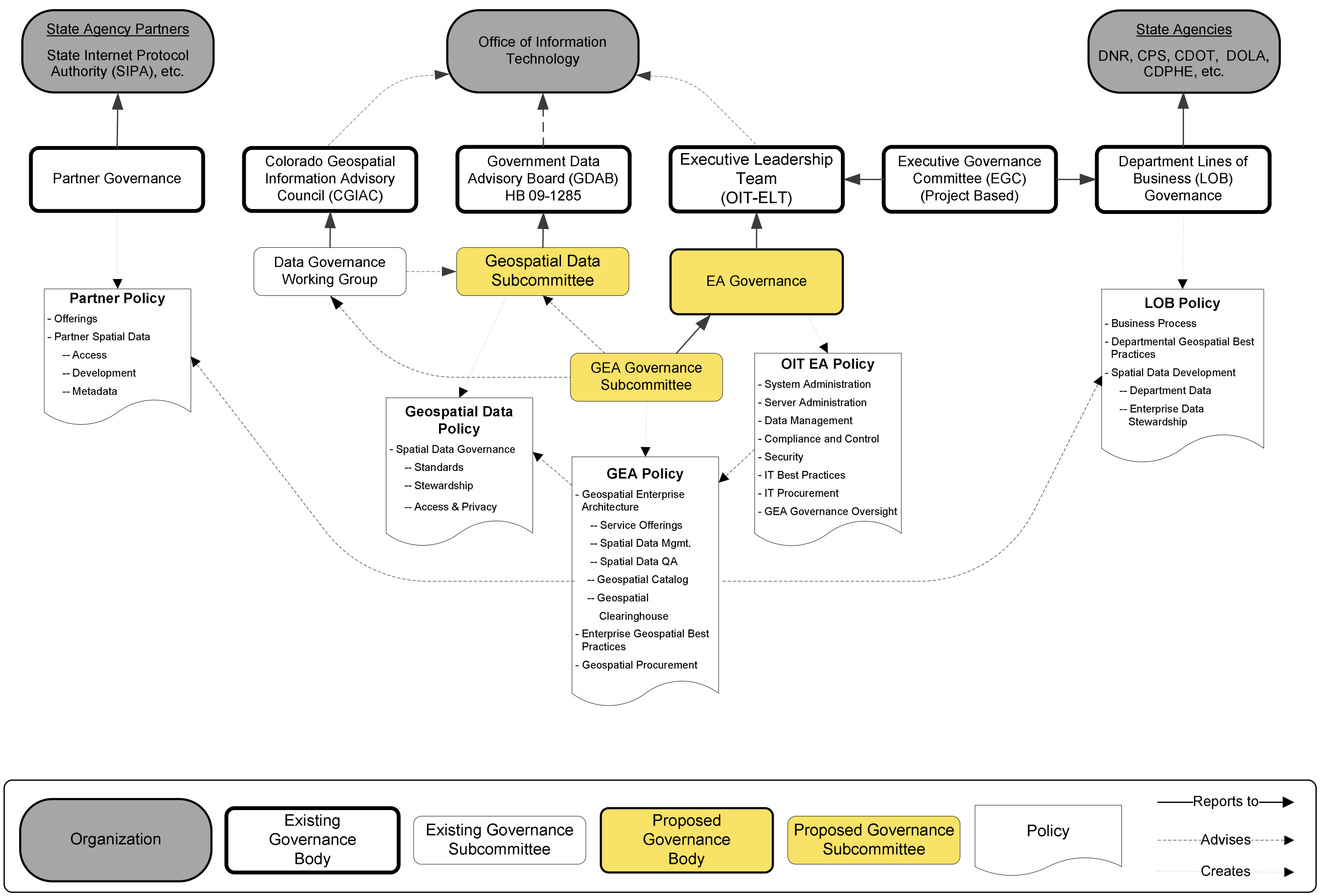
Geospatial data management is complex and creates dependencies between organizational entities that might not otherwise exist. For instance, road centerline data is maintained with inputs from inside and outside of state government (county / local roads and CDOT), and is used by virtually every department in the state for cartography, geocoding, and creation of boundary files, and more. The data governance process recognizes the distinction between departmental and enterprise geospatial data, describes the stewardship roles and responsibilities, and identifies the data stewards for each data layer.

The steward for an enterprise data layer is likely a line of business expert who manages the creation and maintenance of the data in order to accomplish the department's business objectives. A portion, or potentially all, of this data may be useful for other consumers across the enterprise while other data may be useful only to the department. Multiple levels of policy and coordination exist in this scenario:

- The **Line of Business** (LOB) is responsible for determining how the data is collected, maintained, and used within the department as well as defining the data and metadata that comprises the enterprise data for which the department provides stewardship.
- The **Office of Information Technology** (OIT) is responsible for IT policy related to how the data itself is administered (storage, security, redundancy, backup, etc.).
- The **Geospatial Enterprise Architecture** (GEA) is responsible for collecting and defining the need for enterprise data layers, defining and creating the geospatial enterprise offerings, coordinating and managing the flow of enterprise data layers into the clearinghouse, etc. The GEA is a subset of the OIT Enterprise Architecture (EA)
- The **Government Data Advisory Board** (GDAB) is an advisory board to provide advice to the state CIO and is responsible for setting overarching data standards that include geospatial data, identifying the data stewardship process and selecting the stewards, and determining the policies surrounding data access security and privacy.

The following chart identifies the various governance structures and the policies that they are responsible for.

Geospatial Architecture Governance



APPENDIX A - GENERAL TERMS GLOSSARY

- **Application –** a general term used to describe a collection of technology components that facilitate a business process workflow and/or manage data.
- **Application Type Values**
    - **Field Use** – refers to applications that are used or applied in the field e.g. inspection applications loaded on laptops for the use of field inspectors
    - **Data Editing –** applications used specifically for editing data
    - **Data Management –** these applications primarily utilize databases to manage a variety of data types in an RDBMS, such as MS Access, SQL Server or Oracle
    - **Reference –** applications that are used for informational or reference uses, typically for viewing only
    - **Cartography –** applications that are used for map
    - **Analysis –** applications used for analysis purposes requiring more than simple viewing, e.g. to answer complex questions
    - **Tracking –** applications that involve monitoring, locating and tracking phenomena that are geographically distributed and which may change locations over time.
    - **Decision Support –** applications that typically use support of management or executive decision making
    - **Business –** applications driven by specific business processes and related workflow
- **Component –** a well bounded set of technical capabilities that can be combined with other components to create and application or service. Geospatial application components include server infrastructure such as map, data, applications and web servers as well as discrete application components that can be easily repurposed such as web services and generic web-based geospatial viewers.
- **Clearinghouse –** A well-documented process and related infrastructure that collects, maintains updates and provides access to enterprise data layers that have an identified data steward and data owner.
- **Function –** A collection of similar work processes that can be thought of as on-going activities (e.g. system administration)
- **Process** – Discrete tasks groupings that have a specific starting and stopping point (e.g. Perform operating system backup).
- **Replication –** A process that keep separate data stores in synchronization and maintains an authoritative chain of control from centralized master servers and out-lying replicants.
- **Service –** a broad term that denotes several things. Its use should include an additional descriptor such as:
    - **Map Service –** a GIS application server (e.g. ArcIMS, ArcGIS Server) that produces map images and data used for map production and web-based GIS applications
    - **Web Service –** a specialized programming component on an application server that is only accessible when accessed by another program via Internet protocols. (e.g. a geocoding web service)
- **Service Offering –** a consultative capability provided by an individual or organization to another individual or organization. (e.g. map production, geodatabase design)

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APPENDIX B- APPLICATION INVENTORY DATABASE TERMS GLOSSARY

Term	Definition	Values
Application Name	Short descriptive name of application or service that is commonly known	
Application Type	General categories of application use. Please refer to the glossary above for specific value definitions	○ Field Use ○ Data Editing ○ Data Management ○ Reference ○ Cartography ○ Analysis ○ Tracking ○ Decision Support ○ Business ○ TBD
Data Owner	Who owns, updates, and manages the data used by the application or service	
Data Used	The original source of data used by the application	
Delivery Method	The general method that the application's capabilities are provided to the end-user	○ Desktop ○ Web Browser ○ Web Service ○ Field Equipment ○ Client Server ○ TBD
Department	The name of the state agency that owns and manages the application	
Description	A brief description of the application's capabilities and functions	

LOB	The name of the Line of Business within the state agency that is supported by the application	
Skill Level	Describes the level of skill required to use (not create) the application	○ Non-Professional End-User ○ Managerial End-user ○ Casual End-user ○ Specialist End-User ○ GIS Technologist ○ Developer/Administrator ○ TBD
Source	The source of the information provided to the applications inventory	
Supported Processes	A description of the business processes, workflows, and objectives that are supported by the application	
Technology Platform	Commonly used and recognized term that describes the underlying technology used to create application	○ ESRI ArcIMS ○ ESRI ArcGIS Server ○ .NET ○ Google Maps ○ MySQL ○ WMS ○ GPS ○ CADD ○ CAD (Dispatch) ○ ESRI ArcGIS ○ ESRI ArcSDE ○ ESRI Image Server ○ ERDAS Imagine ○ MapInfo ○ Surfer ○ HPAC ○ MapServer ○ PostGres/PostGIS ○ AutoDesk MapGuide ○ SQL-Server Express ○ Cold Fusion ○ Sybase RDMS ○ ArcPad ○ AVG ○ SQL-Server ○ Oracle RDBMS ○ MS Access ○ TBD

Type of Data	The general classification of the data that is used by the application	○ Grid ○ Vector ○ Imagery ○ Tabular ○ Other ○ TBD
Use Level	Describes the extent of the application user community and their frequency of use.	○ 1-2 users, Daily ○ 1-2 users, Weekly ○ 1-2 users, Monthly ○ 3-10 users, Daily ○ 3-10 users, Weekly ○ 3-10 users, Monthly ○ LOB-wide, Daily ○ LOB-wide, Weekly ○ LOB-wide, Monthly ○ Department-wide, Daily ○ Department-wide, Weekly ○ Department-wide, Monthly ○ State-wide, Daily ○ State-wide, Weekly ○ State-wide, Monthly ○ Small group, Occasionally ○ Public, Daily ○ Public, Occasionally

APPENDIX C – APPLICATION INVENTORY

Colorado GIS Application Inventory

Department
LOB

Application Name	Source	Description	Supported Processes	Delivery Method	Technology	Use Level
Wildlife Biology						
Watercode Internet Mapping Application – Internal	DNR GIS Staff	Provides location of waters associated with CDOW Aquatic Section water management code	Provides aquatic field staff and biologists with the	Web Browser		LOB-wide, Weekly
Transportation						
Bridges and Tunnels						
Bridge and Tunnels Database	EM GIS Needs Assessment	TBD	TBD	TBD		TBD
Create locations of transportation projects						
OTIS SAP Functions	CDOT Web Site	Displays maps of transportation projects that enable users to build features representing the locations of transportation projects.	Transportation planning, funding management,	Web Browser		Department-wide, Dai
Early linkage of transportation planning and NEPA analysis						
OTIS PIN	CDOT Web Site	Displays maps of transportation projects and various environmental layers. Enables users to place comments on the map at the location of concern.	Long-range transportation planning, NEPA analysis,	Web Browser		LOB-wide, Monthly
General GIS						
Maps2	EM GIS Needs Assessment	Desktop application used department-wide, customized to display commonly used layers within CDOT's Engineering Regions and TPRs	Cartography; transportation related analysis projects	Desktop		Department-wide, Dai
Hazard Planning and Response/Traffic Management						
Real Time Weather Conditions	EM GIS Needs Assessment	Surveillance systems providing real-time feeds on the CDOT website, on weather conditions, through a distributed set of 86 weather stations, traffic conditions, through the use of cameras. In rural areas State Police provide feedback on conditions up to 4 times a day	Traffic management; public information; weather and	Web Browser		Public, Daily
Highway Maintenance						
MDSS-GPS	EM GIS Needs Assessment	AVL used to track snow plow locations	Highway snow removal; Tracking mobile equipment	TBD		3-10 users, Occasion
Public Accountability						

Tuesday, September 29, 2009 Page 1 of 6

Colorado GIS Application Inventory

Department

LOB

Application Name	Source	Description	Supported Processes	Delivery Method	Technology	Use Level
ARRA Transportation Projects	CDOT Web Site	Displays mapped locations and financial status of ARRA Transportation infrastructure projects.	Public inquiry and accountability	Web Browser		Public, Occasionally
Safe Routes to School	CDOT Web Site	Displays mapped locations and financial status of Safe Routes to School grants.	Public inquiry and accountability	Web Browser		Public, Occasionally
Sharing corridor-specific Transportation Information						
OTIS Corridors	CDOT Web Site	Displays maps of dozens of geographic data layers, most are specific to individual corridors. Enables users to make their own maps and do their own analyses.	NEPA analysis, right-of-way management, corridor	Web Browser		LOB-wide, Monthly
Sharing Integrated Transportation Information						
Highway and Traffic Data Access	CDOT Web Site	Website to access a variety of information related to a segment of a highway. Multiple data categories can be queried on including Description, geometrics, surface, classification etc. based on the specified highway segment	Reference, pavement management, traffic counts	Web Browser		Department-wide, Dai
OTIS MapView	CDOT Web Site	Displays maps, tables, and metadata of dozens of geographic data layers. Enables users to make their own maps.	Pavement management, traffic management and	Web Browser		Department-wide, Dai
Straight Line Diagram	CDOT Web Site	Displays highway segments graphically and geographically. Dozens of highway characteristics can be displayed in combinations specified by the user.	Public inquiry and analysis	Web Browser		Public, Daily

Public Health & Environment

Air Polution Control

Application Name	Source	Description	Supported Processes	Delivery Method	Technology	Use Level
Real-Time Air Monitoring, Other Air Monitoring Sites Map	EM GIS Needs Assessment	2 public facing GIS web applications to query air quality monitoring sites for real-time and other data; Developed by GIS staff; Monitoring station data integrated w/ Yahoo maps using GeoRSS; MySQL back-end database; Additional map services via ArcIMS http://apcd.state.co.us/aqi_map_ve.aspx http://apcd.state.co.us/other_sites_map.aspx	Air Quality Monitoring; Public Awareness of	Web Browser		Public, Daily

Colorado GIS Application Inventory

Department

LOB

Application Name	Source	Description	Supported Processes	Delivery Method	Technology	Use Level
Disease Control						
West Nile Animal Surveillance 2008	CDPHE Web Site	Interactive mapping website showing animals tested for West Nile Virus	Hazard Planning and response	Web Browser		Public, Occasionally
Emergency Response						
Consequences Assessment Tool Set (CATS)	EM GIS Needs Assessment	Tools to create plumes and trajectories for various bio-terrorism scenarios	Modeling to support emergency response	Desktop		TBD
General GIS						
Public Health GIS Applications	EM GIS Needs Assessment	Desktop application used department-wide for disease, hazmat etc.	Cartography; public health hazard planning and	Desktop		Department-wide, Dai
Hazardous Materials and Waste Management						
Site Locator Mapping Application	CDPHE Web Site	This website provides interactive mapping for groups of facilities regulated or remediated by the Hazardous Materials and Waste Management Division.	Public awareness of hazardous material locations	Web Browser		Public, Daily
Unknown	EM GIS Needs Assessment	Interactively refines the locations of hazardous material facilities located through addresses provided with permitting information	Hazardous Materials Management	Web Browser		TBD
Health Statistics						
Web Mapping Application	EM GIS Needs Assessment	Display publicly accessible information	Health Statistics; Public awareness of health data	Web Browser		Public, Daily
TBD						
Data and Map Distribution Website	EM GIS Needs Assessment	Website for distribution of GIS Data and Static maps	Public information and interdepartmental data	Web Browser		Public, Occasionally
Water Quality Control						
Impaired Waters and Water Quality Segmentation of	CDPHE Web Site	2 interactive mapping websites displaying water quality information	Water quality monitoring	Web Browser		Public, Occasionally

Natural Resources

Application Name	Source	Description	Supported Processes	Delivery Method	Technology	Use Level
Facilities Inspection						
COGCC MapGuide Field Application	DNR GIS Recommendation	Field application developed for field staff who conduct inspections of oil and gas facilities and respond to environmental issues	Inspections; hazard response; environmental	Web Browser		LOB-wide, Daily
General GIS						
Geology GIS Applications	DNR GIS Recommendation	Used by each staff member for reference and analysis projects	multiple LOB processes	Desktop		Department-wide, Dai

Colorado GIS Application Inventory

Department

LOB

Application Name	Source	Description	Supported Processes	Delivery Method	Technology	Use Level
Geology GIS Applications	EM GIS Needs Assessment	Maintenance, distribution and application of a variety of geological data	Emergency response involving landslides,	Desktop		3-10 users, Occasion
Wildlife Applications	DNR GIS Staff	Used for several ad-hoc LOB related projects	Inter-departmental support; sampling and modeling of	Desktop		Department-wide, Dai
Geological						
Earthquake and Fault Map Server	DNR GIS Recommendation	Interactive mapping website	Consultant information; academic research; Public	Web Browser		Public, Occasionally
Geological Survey						
Image Processing	EM GIS Needs Assessment	Image processing	Image processing using ERDAS	Desktop	ERDAS Imagine	TBD
Hazard Planning and Response						
HAZUS	EM GIS Needs Assessment	Earthquake modelling software	Earthquake hazard response and planning	Desktop		Department-wide, Mo
Lease Management						
Land Records and Lease Activity Database	DNR GIS Recommendation	Sybase RDMS for updating land records and lease activity	LOB support of primary function	Desktop		LOB-wide, Daily
Permitting						
Oil & Gas Permitting Field Application	DNR GIS Recommendation	Intranet and field deployed mapping and permitting application	Departmental Permitting process	Field Equipment	AutoDesk MapGu	LOB-wide, Daily
Oil & Gas Permitting Mapping Website	DNR GIS Recommendation	Interactive Mapping website with several COGCC and other basemap GIS layers	Public information	Web Browser		Public, Daily
Permitting operational compliance and environmental compliance.						
COGIS/GIS Online – Oil & Gas Permitting Field Application –	DNR GIS Staff	Interactive Mapping website with several COGCC and other basemap GIS layers	Public information	Web Browser		Public, Daily
COGIS/GIS Online – Oil & Gas Permitting Field Application –	DNR GIS Staff	Intranet and field deployed mapping and database application.	Departmental permitting, operational and	Web Browser		LOB-wide, Daily
Reclamation Mining and Safety						
Brasscap System	DNR GIS Staff	Tracks closed mining portals, subsidence and mine fires. Using a GPS enabled, field deployed tablet for data entry and mapping purposes.	Tracks reclamation of abandoned mines.	Desktop		LOB-wide, Daily
DRMS Web Mapping Application	DNR GIS Staff	Interactive mapping website for searching and viewing permits and projects associated with LOB	Public information; analysis	Web Browser		Public, Occasionally
Permit System	DNR GIS Staff	TBD	TBD	Desktop	.NET GPS ESRI ArcGIS	LOB-wide, Weekly

Colorado GIS Application Inventory

Department

LOB

Application Name	Source	Description	Supported Processes	Delivery Method	Technology	Use Level
State Land Board ROW						
ROW Editing	DNR GIS Recommendation	Maintaining data	Editing ROWs and metes and bounds survey	Desktop	ESRI ArcGIS	LOB-wide, Monthly
Water Conservation						
Instream Flow Decision Support System (ISFDSS)	DNR GIS Staff	In-house use system only for determining and mapping existing and potential instream flow water rights.	Analysis support for hydrologists, enginners and	Desktop	ESRI ArcGIS	LOB-wide, Daily
Water Resources						
AquaMap	DNR GIS Recommendation	Web-based application to enter/edit/save/display GIS data. Integrated spatial data entry via heads-up digitizing, metes & bounds tabular entry, copy/paste as well as attribute editing capabilities. On-the-fly data location conversions (PLSS-->UTM, PLSS-->LL, UTM zone conversion). Automated processes to export data for external use. Integrated processes to automatically update information from SQLServer (DWR and OGCC) and linked to the current imaging program to view scanned documents.	LOB for water supply (permitting), water rights	Web Browser		LOB-wide, Daily
AquaMap (Beta)	EM GIS Needs Assessment	Public web based display and query of wells, structures, aerial photos, and DWR scanned maps. Plots well permit locations entered into hydrobase database by well permitters, Allows internal permit evaluators to determine whether wells meet spatial criteria (e.g., adequate spacing between wells or adquate area of parecel on which well is located). Allows permitters to enter parcel boundaries (metes and bounds) or heads-up digitize parcel boundaries on local parcel data background.	Evaluation of well permit applications, water rights	Web Browser		Public, Daily
Colorado Decision Support System	EM GIS Needs Assessment	Water Management System providing current and historical information, ranging from ground water data to water rights	making informed decisions regarding historic and future	Web Browser		Public, Daily

Colorado GIS Application Inventory

Department

LOB

Application Name	Source	Description	Supported Processes	Delivery Method	Technology	Use Level
StateIMS	EM GIS Needs Assessment	Water Management System providing snapshots of information through time, ranging from ground water data to water rights. The sytem is tied to static data sets, necessary for modeling, which get refreshed on an annual basis.	Making informed decisions regarding historic and future	Web Browser		Public, Daily
Water Resources – Not managed by GIS staff. No real GIS application. No XY inf						
Real-time Streamflow	EM GIS Needs Assessment	Provides current stream conditions from over 600 gauging stations located in the State's 7 major river drainages	Emergency response especially flood disasters	Web Browser		Public, Daily
Wildlife Biology						
HB 1298 Habitat Impact Assessment Tool	DNR GIS Staff	Provides habitat information for proposed oil and gas well locations.	Enables quick and consistent response to well	Web Browser		3-10 users, Daily
Natural Diversity Information Source (NDIS)	DNR GIS Staff	Custom web-delivery system to view and download Dept. of Wildlife species and reference data	Public information; analysis tool for planners and	Web Browser		Public, Daily

Public Safety

Colorado State Patrol Dispatch

Application Name	Source	Description	Supported Processes	Delivery Method	Technology	Use Level
Premier Computer Aided Dispatch (CAD), Advanced	Public Safety	This system is used to dispatch 64 Law, Fire and EMS agencys state wide. We should receive 1 millon calls for service this year and the system has a 99.999% up time.	Dispatch and tracking units	Client Server		LOB-wide, Daily
Crime Mapping						
Colorado Incident Mapping System (CIMS)	Public Safety	Used by Colorado State Patrol to map our incident data from our Computer Aided Dispatch (CAD) system	Trend analysis; proactive officer placement	Web Browser		LOB-wide, Daily